Monocular SLAM for Smart SPHERES

Completed Technology Project (2014 - 2018)

Project Introduction

Simultaneous Localization and Mapping (SLAM) in robotics, is when a robot constructions a set of geometrical features of its environment (mapping) and uses sensing to estimate where it is relative to those features (localization). For example, the robot learns where walls are in a building and then can learn how to navigate between a start and goal without hitting them. SLAM sensors have been lidar (3D laser sensor like on Kinect) or bi/tri-ocular (two or three image cameras). This proposal suggests the use of a monocular sensor which is just a single camera that records images without any 3D data. Using the accelerometer and gyroscope along with the camera in a smartphone, some 3D information can be recovered. By using computer vision techniques, the sets of features are found in a sequence of camera frames. From the accelerometer and gyroscope data these are then fitted to statistical estimates of where these features are in the 3D environment. Then using sensor fusion techniques the data is compiled and then traditional SLAM algorithms are used. This would allow SLAM within lower weight, cost, and power sensors. The Smart SPHERES are a direct application of monocular SLAM that are being used to research robotic autonomy. Robotic navigation autonomy is important because it enables robots to aid astronauts with their numerous tasks around the space station with their highly limited time. Second, the technology extends to exploration probes such as the mars rovers which have too much of a communication time delay to be operated purely by teleoperation.

Anticipated Benefits

This project would allow SLAM within lower weight, cost, and power sensors. The Smart SPHERES are a direct application of monocular SLAM that are being used to research robotic autonomy. Robotic navigation autonomy is important because it enables robots to aid astronauts with their numerous tasks around the space station with their highly limited time. The technology extends to exploration probes such as the mars rovers which have too much of a communication time delay to be operated purely by teleoperation.

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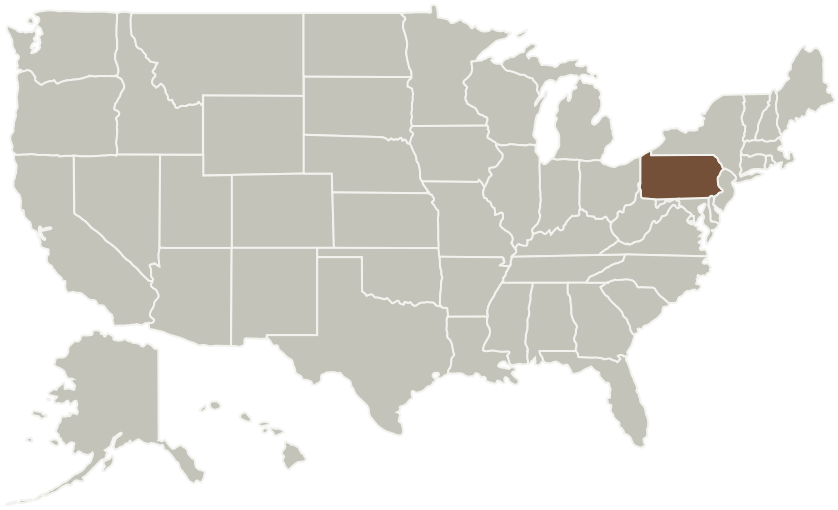
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Pennsylvania	Lead Organization	Academia	Philadelphia, Pennsylvania

Primary U.S. Work Locations
Pennsylvania

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Pennsylvania

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Vijay P Kumar

Co-Investigator:

Michael A Watterson

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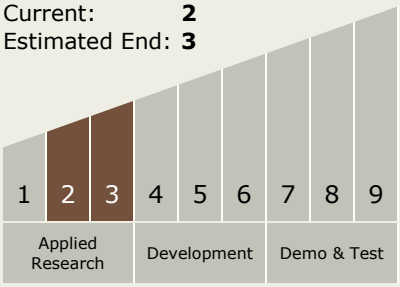
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.5 Autonomous Rendezvous and Docking
    - TX04.5.1 Relative Navigation Sensors

Target Destinations

Earth, Foundational Knowledge